PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:
TSUKASA OHNISHI
Application No.: 10/682,305 Art Unit: 1742
Filed: October 10, 2003 Examiner: Sikyin Ip
For: LEAD-FREE SOLDER

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Tsukasa Ohnishi, declare as follows:

1. I am the inventor of the present application and an employee of Senju Metal Industry, Co., Ltd, which is the assignee of the application.

2. I received an undergraduate degree from the Department of Materials Science and Engineering at Muroran Institute of Technology. I have been engaged in the research and development of solder alloys since 1999. As such, I have considerable experience in the properties of commercial alloys for use in the manufacture of electronic devices.

3. I now work in the research and development department of Senju. My principal duties at Senju are development of solder alloys.

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4. The present application includes a claim describing a lead-free solder which consists essentially of 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn. This claim encompasses alloys which include only the elements Sn, Cu, Co, and Ni in the claimed ranges, and it encompasses alloys which further include components which do not materially affect the basic and novel characteristics of a composition containing only Sn, Cu, Co, and Ni in the claimed ranges.

5. As set forth on page 5, lines 8 - 15 of the present application, a significant feature of a Sn-Cu-Co-Ni alloy in the claimed range is that it has a very low tendency to cause copper leaching when it is used to precoat coil ends of thin copper wire or when such coil ends are dipped in molten solder. The ability of this alloy to reduce copper leaching is illustrated by Examples 2 - 4 in Table 1 of the present application. Each of these examples of a Sn-Cu-Co-Ni alloy according to the present invention has a low leaching speed far below that of the comparative examples (Examples 11 - 15).

6. Another significant feature of an alloy containing only 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn is that it has a low material cost which is comparable to that of conventional alloys used for coating of coil ends.

7. Conventional lead-free solders used for dip coating of copper wires which have been proposed in the past generally have a unit cost, at present market prices for raw materials, in the range of $5 - $15 per kg. An alloy having a price significantly outside of this range is unacceptable from a commercial standpoint for coating of copper wires.

8. Illustrative of conventional alloys in the above range are the following:

8.1 One example of such a conventional alloy is the conventional Pb-Sn-Cu alloy discussed on page 3, lines 22 - 27 of the present application. This alloy is a Pb-63Sn alloy to which Cu is added to give a Cu content of 1.5 - 2 weight %. This alloys has a maximum unit cost of $5.41/kg, which is for an alloy containing 1.5 wt % of Cu (calculated at a unit cost of $.99/kg for Pb, $8.06/kg for Sn, and $3.29/kg for Cu).

8.2 Additional examples of such a conventional alloy are the conventional lead-free solders disclosed in JP 2001-121286 and discussed on page 4, lines 10 - 14 of the present application. Table A at the end of this declaration shows the unit costs of each of the examples disclosed in JP 2001-121286. The unit costs of these examples range from $7.68 to $10.26/kg, and the average cost of the 14 examples in Table A is $8.54.

8.3 Further examples of conventional alloy for coating of coil ends are the conventional lead-free solders disclosed in JP 2001-334384 and discussed on page 4, lines 14 - 19 of the present application. Table B at the end of this declaration shows the unit costs of the examples shown in Table 1 of that reference. All of the examples except for Example 9 have a unit cost ranging from $7.39 to $15.66/kg. Example 9, which contains 10 wt % of In, has a unit cost of $103/kg. On account of its cost, the alloy of Example 9 would never be used for coating of copper wires and is impractical. The average cost of the other thirteen examples in Table B is $8.71/kg.

9. An alloy containing only 1.5 - 8 mass % of Cu, 0.01 -

2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn has a low unit cost falling within the price range of conventional alloys. The most expensive alloy containing only 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn is one containing 1.5 mass % of Cu (costing $3.29/kg), 2 mass % of Co (costing $38.50/kg), 1 mass % of Ni (costing $16.46/kg), and 95.5 mass % of Sn (costing $8.06/kg). This alloy has a unit cost of $8.68/kg.

10. The desire for economy in an alloy according to the present invention is made clear by the statement on page 9, lines 16 - 19 of the present application that it is undesirable to add Ag (which is an expensive alloying element) in excess of 2 mass %, since doing so unnecessarily increases costs.

11. An alloy consisting essentially of 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn is not restricted to an alloy containing only Sn, Cu, Co, and Ni. It may further include, for example, (a) at least one oxidation-inhibiting element selected from the group consisting of P, Ge, and Ga, with the total amount of these elements being 0.001 - 0.5 mass %, and/or (b) Ag in an amount of 0.05 - 2 mass %. Examples of such alloys are shown in Table 1 of the present application. These additional elements enhance properties of the alloy while maintaining the ability of the alloy to inhibit copper leaching. Alloys according to the present invention which includes these additional elements also have a low unit cost comparable to that of conventional alloys for precoating coil ends. Table C at the end of this declaration shows the unit cost calculated for each of the examples of alloys according to the present invention in Table 1 of the present application. The unit cost of these ten examples ranges from $7.97 to $12.80, with

an average price of $8.97/kg.

12. Thus, among the basic and novel characteristics of an alloy consisting essentially of 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn are that it has a very low tendency to cause copper leaching when used to precoat coil ends of thin copper wire and that it has a cost comparable to that of conventional lead-free solders for coating of copper wires.

13. The language "consisting essentially of 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn" does not encompass any of the alloys disclosed in Japanese Published Unexamined Patent Application No. 55-20403 (referred to below as JP 55-20403) because that reference requires components which would materially affect the basic and novel characteristics of an alloy containing only 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn.

14. JP 55-20403 discloses various Sn-Au based alloys. Every alloy disclosed in JP 55-20403 contains 10 - 85 weight % of Au and 15 - 90 weight % of Sn. Thus, 1 kg of any alloy according to JP 55-20403 contains at least 0.1 kg (= 10 weight %) of Au and 0.15 kg (= 15 weight %). At a unit price of $13784.61/kg for Au and $8.06/kg for Sn, the cost of just this amount of Au and Sn in any alloy according to JP 55-20403 is as follows:

0.1 kg Au)($13784.61/kg Au) + (0.15 kg Sn)($8.06/kg Sn) =

$1379.67/kg

15. Thus, the unit cost of any alloy according to JP 55-

20403 must be greater than $1379.67/kg. This means that the minimum unit cost of an alloy according to JP 55-20403 costs from 92 to 276 times the unit cost ($5 - $15) of conventional alloys for coating copper wire and 108 times the unit cost of the most expensive example shown in Table 1 of the present application (Example 9, having a unit cost of $12.80/kg).

16. As such, the addition of the amount of Au required by JP 55-20403 to an alloy containing only 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn would drastically change its properties, rendering the alloy prohibitively expensive and totally unsuitable for its intended use of coating copper wires. Since this amount of Au would materially affect the basic and novel characteristics of the alloy, it is excluded from the language "consisting essentially of 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn". Therefore, JP 55-20403 does not teach such an alloy.

17. For the same reasons that the alloys disclosed in JP 55-20403 are not encompassed by a composition consisting essentially of 1.5 - 8 mass % of Cu, 0.01 - 2 mass % of Co, 0.01 - 1 mass % of Ni, and a remainder of Sn, as a designer of alloys, I would never contemplate using any of the alloys disclosed in JP 55-20403 for the purpose of precoating a copper wire, nor could I imagine another person skilled in the art doing so. The sole use for which the alloy of JP 55-20403 is intended is for the brazing of external portions of a wrist watch. These are portions which are normally exposed to the elements or to sweat and grease from the wearer of the watch during its use. Since a watch is often treated as a form of jewelry, it is often desirable to prevent visible corrosion which could mar its value as an ornament. A high content of Au will give the alloy corrosion resistance. Given the need

to maintain the appearance of a watch, it may be acceptable to use an expensive alloy for brazing, particularly with a luxury watch. The requirements of maintaining appearances and protection against the environment are lacking when a solder is used to coat copper wires prior to soldering. Therefore, to me, the use of any alloy according to JP 55-20403 for coating a copper wire is impractical and not reasonable.

18. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

Tsukasa Ohnishi

Tsukasa Ohnishi
Tokyo, Japan

Date: September 1, 2005

Table A

Unit cost of alloys in examples of JP 2001-121286

Example No.	Alloy composition (wt %)						Total cost/kg of alloy
	Sn: $8.06/kg	Cu: $3.29/kg	Ag: $226.66/kg	Ni: $16.46/kg	Ge: $603/kg	Au: $13784.61/kg	
1-1	94.5	5.5					$7.80
1-2	94	6					$7.77
1-3	93.5	6.5					7.75
1-4	93	7					7.72
1-5	92.5	7.5					7.70
1-6	92	8					$7.68
2-1	92.989	7	0.01	0.001			$7.75
2-2	92.898	7	0.1	0.002			$7.94
2-3	92.495	7	0.5	0.005			$8.82
2-4	92.292	7	0.7	0.008			$9.26
2-5	92.99	7	1.0	0.01			$9.99
3-1	92.485	7	0.5	0.005	0.01	0	$8.88
3-2	92.485	7	0.5	0.005	0	0.01	$10.20
3-3	92.475	7	0.5	0.005	0.01	0.01	$10.26

Table B

Unit cost of alloys in examples of JP 2001-334384

Example No.	Alloy composition (wt %)										Total cost/kg of alloy
	Sn: $0.06/kg	Cu: $3.29/kg	Ni: $16.46/kg	Ag: $226.66/kg	In: $950/kg	Bi: $8.32/kg	Zn: $1.25/kg	Sb: $3.38/kg	Ge: $10.98/kg	F: $.23/kg	
1	97.99	2.50	0.01								$7.98
2	97.85	2.50	0.15								$7.99
3	97.85	2.50	0.30								$8.02
4	97.50	2.50	0.50								$8.02
5	94.99	5.00	0.01								$7.82
6	94.85	5.00	0.15								$7.83
7	94.5	5.00	0.50								$7.86
8	94.2	2.50	0.30	3.50							$15.66
9	97.7	2.50	0.30		10.00						$103
10	94.7	2.50	0.30			3.00					$8.01
11	88.7	2.50	0.30				9.00				$7.39
12	92.7	2.50	0.30					5.00			$7.77
13	97.2	2.50	0.30						0.50		$10.98
14	97.2	2.50	0.30							0.50	$7.96

Table C

Unit cost of alloys in Table 1 of this application

Example No.	Alloy composition (wt %)								Total cost/kg of alloy
	Sn: $8.06/kg	Cu: $3.29/kg	Co: $38.50/kg	Ni: $16.46/kg	P: $.23/kg	Ge: $603/kg	Ga: $550/kg	Ag: $226.66/kg	
1	97.99	2	0.01						$7.97
2	97.69	2	0.3	0.01					$8.06
3	93.7	4	2	0.3					$8.50
4	90	8	1	1					$8.61
5	97.48	2	0.5		0.02				$8.12
6	96.45	2	1	0.5		0.05			$8.61
7	95.0	4	0.5	0.2			0.3		$9.66
8	93.3	6	0.3	0.3	0.02	0.01	0.07		$8.33
9	95.52	2	0.2	0.2	0.01		0.07	2	$12.80
10	97.22	2	0.2	0.2	0.01		0.07	0.3	$9.08

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